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JAPANESE

[JP,06-114000,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE
INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF
DRAWINGS DRAWINGS

[Translation done.]

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CLAIMS

[Claim(s)]

[Claim 1] The medical-application manipulator carry out it having been prepared in two or more curve operation meanses which are connected with the insertion section which has two or more bends in a nose-of-cam side, the control unit prepared in the end face section of this insertion section, and two or more aforementioned bends of each, and carry out curve operation of each, and the aforementioned control unit, and having provided the external curve operation means which can connect with arbitrary curve operation meanses freely among two or more aforementioned curve operation meanses as the feature.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to medical-application manipulators, such as an endoscope.

[0002]

[Description of the Prior Art] The endoscope generally used when inspecting visually the inside of a living body's coelome and the pipe of industrial use piping etc. consists of the insertion section inserted into a living body's coelome and the pipe of industrial use piping etc., and a control unit prepared in the end face section of this insertion section, and the bend is prepared in the nose-of-cam side of the insertion section. This bend connects two or more **** free [rotation] by the rivet etc., is formed, and can curve freely to the vertical direction and a longitudinal direction to the shaft orientations of the insertion section.

[0003] On the other hand, the 1st curve operating knob as a curve operation means and the 2nd curve operating knob are prepared in the control unit of an endoscope free [rotation on the same axle], and the angle wire which incurvates a bend carries out attitude operation by carrying out rotation operation of these curve operating knobs at the shaft orientations of the insertion section.

[0004] By the way, since such an endoscope cannot incurvate a bend in a configuration like a wave, it has the problem that it is not easy to insert the insertion section along with the duct of complicated configurations, such as a living body's small intestine.

[0005] Then, in order to solve such a problem, two or more bends are prepared in the nose-of-cam side of the insertion section in series, and the thing which enabled it to insert the insertion section of an endoscope along with the duct of a complicated configuration is proposed.

[0006]

[Problem(s) to be Solved by the Invention] However, although it had the advantage that medical-application manipulators, such as such an endoscope, could insert the insertion section along with the duct of a complicated configuration, since it was necessary to prepare the curve operation means of the number corresponding to the bend in a control unit, there was a problem that a control unit was enlarged.

[0007] It was made in view of such a trouble, the purpose does not need to prepare the curve operation means of the number corresponding to the bend in a control unit, and this invention is to offer the medical-application manipulator which can attain the miniaturization of a control unit.

[0008]

[Means for Solving the Problem] The medical-application manipulator applied to this invention in order to solve the above-mentioned technical problem The insertion section which has two or more bends in a nose-of-cam side, and the control unit prepared in the end face section of this insertion section, It is characterized by having been prepared in two or more curve operation meanses which are connected with two or more aforementioned bends of each, and carry out curve operation of each, and the aforementioned control unit, and providing the external curve operation means which can be freely connected with arbitrary curve operation meanses among two or more aforementioned curve operation meanses.

[0009]

[Function] this invention of such composition serves as a curve operational arbitrarily by external curve operation means by which two or more bends prepared in the nose-of-cam side of the insertion section were prepared by the control unit.

[0010]

[Example] First, the 1st example of this invention is explained with reference to drawing 1 or drawing 13. In drawing 1, 10 shows the medical-application manipulator concerning the 1st example of this invention. This medical-application manipulator 10 consists of the insertion section 11 inserted into a living body's coelome and the pipe of industrial use piping etc., and a control unit 12 prepared in the end

face section of this insertion section 11, and Bends 13a and 13b are formed in the nose-of-cam side of the insertion section 11 in series.

[0011] These bends 13a and 13b are formed with the curve tube 61 as shown in drawing 4 , and this curve tube 61 has a thin-walled part 62 and a heavy-gage part 63, and has structure which is easy to curve in the direction of a thin-walled part 62 focusing on the supporting point 64 as shown in drawing 5 (a) and (b). Moreover, since this curve tube 61 has structure which it was formed by resin material, such as homogeneous PTFE, and was closed to the periphery, it has the advantage of not needing other members for maintaining sealing nature. Moreover, this curve tube 61 is fabricated by the metal mold 65 shown in drawing 6 (a) and (b).

[0012] That is, after passing material which carried out heating fusion, such as a resin, in the crevice 69 between the metal mold 65 which consists of master molds 66 and 67 and a core 68 and cooling in it, the curve tube 61 is picked out from metal mold 65. In addition, since the periphery has become tooth-like, that it is hard to insert in case it inserts into a living body's coelome, it may cut or un-arranging [of dirt adhering] may produce the curve tube 61 fabricated with the metal mold 65 shown in drawing 6 (a) and (b). In such a case, the curve tube which has the concavo-convex section in an inner circumference side can be obtained using the metal mold 70 shown in drawing 7 (a) and (b) by slushing resin material, such as PTFE, into the crevice 74 between the master molds 71 and 72 of this metal mold 70, and a core 73.

[0013] In addition, since the metal mold 70 shown in drawing 7 serves as an undercut in case it removes a curve tube from a core 73, the curve tube in this case needs to be a comparatively flexible material which permits an undercut. When selection of material with this property is difficult, as shown in drawing 9 , a periphery can obtain the smooth curve tube 78 by carrying out compressed-air formula fabrication with the metal mold 75 which shows the curve tube 61 of the configuration shown in drawing 4 to drawing 8 . That is, as shown in drawing 8 , by inserting the curve tube 61 in metal mold 75, supplying the compressed air from an inlet 76 after heating metal mold 75, and pressurizing the pressurized room 76 of metal mold 75, the curve tube 61 imitates the smooth inner mold of metal mold 75, and is fabricated. In addition, the air which exists in the crevice between metal mold 75 and the curve tube 61 at this time is discharged from an outlet 77.

[0014] Drawing 10 shows the outline composition of the department operation equipment of low invasion peritoneal-cavity inside and outside used for the operation in peritoneal cavity under an endoscope. As shown in this drawing, this department operation equipment of low invasion peritoneal-cavity inside and outside consists of the multi-joint micromanipulator 81, the micro gripper 82, the micro clip micro suture instrument 83 for ligation, the micro substance endoscope 84, a micro tactile sensor 85, a manipulator style 86 for remote control, and three-dimensions display unit 87 grade, and conducts the operation in peritoneal cavity by the following methods. That is, a pneumoperitoneum needle is first inserted in a patient's abdomen 88, and the pneumoperitoneum of the inside of peritoneal cavity 89 is carried out. Next, the multi-joint micromanipulator 81 is inserted through the mind abdominal-pore shell truck curl 90, internal organs are held by the micro gripper 82 with a tactile sensor, and a field of operation is secured. Next, when extracting the gallbladder, the gallbladder is raised by the micro gripper 82, a RF scalpel cuts and the gallbladder is extracted, after ligating a gallbladder pipe and a vessel with the micro clip 83, as shown in drawing 11 . In addition, the substance endoscope 84 carried in the multi-joint micromanipulator 81 performs observation in the peritoneal cavity 89 at this time. Moreover, a way person performs an operation by the manipulator style 86 for remote control at this time, looking at the stereoscopic image projected on the three-dimensions display unit 87.

[0015] such department operation equipment of low invasion peritoneal-cavity inside and outside of composition -- a patient's abdomen 88 -- insertion -- since what is necessary is just to open only one hole, the degree of invasion to a patient has an advantage of a low extremely Moreover, since a way person can perform the surgical operation in peritoneal cavity, looking at the stereoscopic image in peritoneal cavity 89, he can perform an operation with the same feeling as the surgical operation by incision in the abdomen. In addition, 91 in drawing 11 shows the relative-position detection sensor.

[0016] Drawing 12 (a) and (b) are drawings showing the outline composition of the micro gripper 82

shown in drawing 10 , and this micro gripper 82 has the grasping section 92 for grasping the internal organs in peritoneal cavity. This grasping section 92 is connected to the link section 93, and the end of a wire 94 is connected to the other end of the link section 93. The other end of this wire 94 has fixed to axis-of-rotation 95a of a motor 95.

[0017] The nose-of-cam shaft of the aforementioned link section 93 is being fixed to the frame 96. The back end section of this frame 96 is connected with the front end section of a frame 98 free [rotation] through the joint section 97, and the back end section of a frame 98 is connected with the front end section of a frame 100 free [rotation] through the joint section 99. Standing ways 101 are formed in the back end section of this frame 100 at one, and the motor 102,104 is being fixed while the motor 95 mentioned above is being fixed on standing ways 101.

[0018] The end of a wire 106,107 is attached firmly to the axis of rotation 103 of the aforementioned motor 102. The other end of these wires 106,107 is attached firmly to the joint section 97 by the side of a nose of cam, and if a motor 102 is driven, one side of a wire 106,107 is pulled and another side is loosened, a frame 96 will rotate the joint section 97 as the supporting point.

[0019] The end of a wire 108,109 is attached firmly to the axis of rotation 105 of the aforementioned motor 104. The other end of these wires 108,109 is attached firmly to the joint section 99, and if a motor 104 is driven, one side of a wire 108,109 is pulled and another side is loosened, a frame 98 will rotate the joint section 99 as the supporting point.

[0020] Drawing 13 is drawing showing the outline composition of the manipulator 110 for operation formed at the nose of cam of the manipulator style 86 for remote control shown in drawing 10 , and this manipulator 110 for operation has the control unit 111 at the nose of cam. This control unit 111 is connected to the link section 112, and the end of a wire 113 is connected to the other end of the link section 112. The other end of this wire 113 is connected with the axis of rotation 115 of an encoder 114.

[0021] The nose-of-cam shaft of the aforementioned link section 112 is being fixed to the frame 116. The back end section of this frame 116 is connected with the front end section of a frame 118 free [rotation] through the joint section 117, and the back end section of a frame 118 is connected with the front end section of a frame 120 free [rotation] through the joint section 119. Standing ways 121 are formed in the back end section of this frame 120 at one, and the encoder 122,124 is being fixed while the encoder 114 mentioned above is being fixed on standing ways 121.

[0022] The end of a wire 126,127 is attached firmly to the axis of rotation 123 of the aforementioned encoder 122. The other end of these wires 126,127 is attached firmly to the joint section 117 by the side of a nose of cam.

[0023] The end of a wire 128,129 is attached firmly to the axis of rotation 125 of the aforementioned motor 124. The other end of these wires 128,129 is attached firmly to the joint section 119.

[0024] Drawing 14 is drawing showing the composition of the globe 130 for operation, and the manipulator 131 for operation is formed in the finger part shell side of this globe 130 for operation. The end face section of this manipulator 131 for operation is connected to the amount detecting element 132 of drives of a wrist outside.

[0025] Drawing 15 is the block diagram of the manipulator 131 for operation, and this manipulator 131 for operation has fixed the end of a wire 134 to the nose-of-cam side of a finger part 133, and is fixing the other end of a wire 134 to the axis of rotation of an encoder 138 through the pulley 135 of the 1st joint section, the pulley 136 of the 2nd joint section, and the pulley 137 of the 3rd joint section.

[0026] The end of a wire 139 is attached firmly to the axis of rotation of the aforementioned pulley 135. The other end of this wire 139 is attached firmly to the axis of rotation of an encoder 140. Moreover, if the globe 130 for operation of such composition of that the end of a wire 141 is attached firmly to the axis of rotation of the aforementioned pulley 136, and the other end of this wire 141 is attached firmly to the axis of rotation of an encoder 142 makes a finger part 133 crooked, each corresponding wire 134,139,141 will be led and each encoder 138,140,142 will detect this amount of tension. The manipulator for the operation in a coelome is driven based on this detecting signal. In addition, you may transmit a detecting signal by the telemetry.

[0027] As shown in the nose-of-cam side inner skin of the curve tubes 61 and 61 which form the

aforementioned bends 13a and 13b at drawing 4 , the curve operation wires [14a, 14b, 14c, 14d, 15a, 15b, 15c, and 15d] end is attached firmly to the hoop direction of the curve tubes 61 and 61 at intervals of 90 abbreviation. The these curve operation wires [14a, 14b, 14c, 14d, 15a, 15b, 15c, and 15d] other end inserts in the inside of the insertion section 11, and is drawn in the control unit 12.

[0028] In the aforementioned control unit 12, as shown in drawing 1 and drawing 2 , the curve operation wires 14a and 14b and chain 16a are minded for bend 13a. The 1st curve direction (It is hereafter called the "vertical direction" for convenience.) Gear 17a to incurvate, gear 17b which incurvates bend 13b in the vertical direction through the curve operation wires 15a and 15b and chain 16b, The 2nd curve direction which intersects bend 13a perpendicularly with the 1st curve direction through the curve operation wires 14c and 14d and chain 16c (it is hereafter called a "longitudinal direction" for convenience.) Gear 17d which incurvates gear 17c to incurvate and bend 13b to a longitudinal direction through curve operation wirec [15] and 15d and chain 16d is prepared.

[0029] the external tooth 18 (refer to drawing 3) for these gears 17a, 17b, 17c, and 17d making the shape of a ring, and driving Chains 16a, 16b, 16c, and 16d to the periphery side -- moreover, the internal tooth 19 (refer to drawing 3) for rotating an external tooth 18 is formed in the inner circumference side In addition, in the gearbox 20, the above-mentioned gears 17a, 17b, 17c, and 17d make the center of rotation in agreement, are held, and are held by two or more ball bearing 21 -- free [rotation], respectively. These ball bearing 21 -- is engaging with guide slot 22 -- of the shape of a ring formed in Gears [17a, 17b, 17c, and 17d] both sides, as shown in drawing 3 .

[0030] Moreover, in the aforementioned control unit 12, the gears 23a and 23b which engage with the Gears [17a 17b, 17c, and 17d] internal tooth 19, and drive the Gears [17a 17b, 17c, and 17d] external tooth 18 are formed. These gears 23a and 23b are movable to the Gears [17a, 17b, 17c, and 17d] direction of the axis of rotation, and the end of connection cylinder 24a is connected with the core of gear 23a. The other end of this connection cylinder 24a is projected out of the control unit 12, and curve operating-knob 25a as an external curve operation means is attached in the protrusion edge. Moreover, the end of connecting-shaft 24b is connected with the core of gear 23b. The other end of this connecting-shaft 24b inserted in the inside of connection cylinder 24a, and has projected it out of the control unit 12, and curve operating-knob 25b as an external curve operation means is attached in the protrusion edge.

[0031] Thus, if gear 23a carries out rotation operation of the curve operating-knob 25a in the state where it is engaging with the internal tooth 19 of gear 17a, rotation of curve operating-knob 25a will get across to gear 17a through gear 23a, and chain 16a will drive the 1st example of this invention constituted by rotation of gear 17a. One side of the curve operation wires 14a and 14b is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13a curves in the vertical direction.

[0032] Moreover, if gear 23a carries out rotation operation of the curve operating-knob 25a in the state where it is engaging with the internal tooth 19 of gear 17b, rotation of curve operating-knob 25a will get across to gear 17b, and chain 16b will drive by rotation of gear 17b. One side of the curve operation wires 15a and 15b is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13b curves in the vertical direction.

[0033] Furthermore, if gear 23a carries out rotation operation of the curve operating-knob 25a in the state where it is engaging with the internal tooth 19 of both gears 17a and 17b, rotation of curve operating-knob 25a will get across to Gears 17a and 17b, and Chains 16a and 16b will drive by rotation of Gears 17a and 17b. Either the curve operation wires 14a and 14b, or 15a and 15b are pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, Bends 13a and 13b curve in the vertical direction.

[0034] On the other hand, if gear 23b carries out rotation operation of the curve operating-knob 25b in the state where it is engaging with the internal tooth 19 of gear 17c, rotation of curve operating-knob 25b will get across to gear 17c through gear 23b, and chain 16c will drive by rotation of gear 17c. Curve operation wires [14c and 14d] one side is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13a curves to a longitudinal direction.

[0035] Moreover, if gear 23b carries out rotation operation of the curve operating-knob 25b in the state

where it is engaging with the internal tooth 19 which is gear 17d, rotation of curve operating-knob 25b will get across to gear 17d, and chain 16d will drive by rotation of gear 17d. Curve operation wires [15c and 15d] one side is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13b curves to a longitudinal direction.

[0036] Furthermore, if gear 23b carries out rotation operation of the curve operating-knob 25b in the state where it is engaging with the internal tooth 19 of both which are Gears 17c and 17d, rotation of curve operating-knob 25b will get across to Gears 17c and 17d, and Chains 16c and 16d will drive by rotation of Gears 17c and 17d. The curve operation wires 14c and 14d and one side (15c and 15d) are pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, Bends 13a and 13b curve to a longitudinal direction.

[0037] Therefore, in the 1st example of such this invention of composition, since it is not necessary to incurvate independently Bends 13a and 13b to the vertical direction and a longitudinal direction by two curve operating knobs 25a and 25b, and to prepare a curve operating knob in a control unit like before corresponding to the number of bends, the miniaturization of a control unit 12 can be attained.

[0038] In addition, although Gears 23a and 23b were made to engage with the Gears [17a 17b, 17c, and 17d] internal tooth 19 and Bends 13a and 13b were incurvated to the vertical direction and the longitudinal direction in the 1st example of this invention mentioned above Bends 13a and 13b to the vertical direction and a longitudinal direction as a gear which carries out a curve drive through the curve operation wires 14a, 14b, 14c, 14d, 15a, 15b, 15c, and 15d and Chains 16a, 16b, 16c, and 16d As shown in drawing 16 , the gears 26a, 26b, 26c, and 26d which have two external teeth 27a and 27b are used for a periphery side. Gears 23a and 23b are made to engage with these gears [26a, 26b, 26c, and 26d] external-tooth 27b, and you may make it incurvate Bends 13a and 13b to the vertical direction and a longitudinal direction.

[0039] Moreover, as shown in drawing 17 , the middle gears 28a and 28b are formed between Gears 26a, 26b, 26c, and 26d and Gears 23a and 23b, and you may make it move these middle gears 28a and 28b to Gears [26a 26b, 26c and 26d] shaft orientations by the operating rod 29.

[0040] Next, the 4th example of this invention is explained with reference to drawing 18 and drawing 19 . In addition, the same sign is attached and explained to the same portion as what was shown in drawing 1 . In drawing 18 , 30 shows the control unit of the medical-application manipulator concerning the 4th example of this invention. Gear 31a which incurvates bend 13a (refer to drawing 1) in the vertical direction through the curve operation wires 14a and 14b (refer to drawing 4) and chain 16a in this control unit 30, Gear 31b which incurvates bend 13a to a longitudinal direction through the curve operation wires 14c and 14d (refer to drawing 4) and chain 16c, Gear 32a which incurvates bend 13b (refer to drawing 1) in the vertical direction through the curve operation wires 15a and 15b (refer to drawing 4) and chain 16b, Gear 32b which incurvates bend 13b to a longitudinal direction through curve operation wire [15] and 15d (refer to drawing 4) and chain 16d is prepared.

[0041] the inside of these gears 31a, 31b, 32a, and 32b -- connection tubed to the core of Gears 31a and 32a -- Members 33a and 33b are connected these connection -- Members 33a and 33b are projected out of the control unit 30, and the curve operating knobs 35a and 35b as an external curve operation means are attached in the protrusion edge Moreover, connecting shafts 34a and 34b are connected with the core of Gears 31b and 32b. these connecting shafts 34a and 34b -- connection -- the inside of member 33a and 33b was inserted in, it has projected out of the control unit 30, and the curve operating knobs 35c and 35d as an external curve operation means are attached in the protrusion edge

[0042] Moreover, in the aforementioned control unit 30, the idler gears 36a and 36b which tell rotation of Gears 31a and 31b or Gears 32a and 32b to Gears 32a and 32b, or 31a and 31b are formed. These idler gears 36a and 36b are held free [rotation] at the operation shaft 37, and are estranged from Gears 31a and 31b and Gears 32a and 32b by moving this operation shaft 37 to the longitudinal direction of a control unit 30.

[0043] In the 4th example of such this invention of composition, the curve operating knobs 35a, 35b, 35c, and 35d can be moved independently, and insertion to a complicated duct like the large intestine becomes easy. Moreover, curve length is freely changeable in narrow space by using only the curve

operating knobs 35a and 35b, and using the curve operating knobs 35a and 35b and the curve operating knobs 35c and 35d in latus space, interlocking.

[0044] Next, the 5th example of this invention is explained with reference to drawing 20 or drawing 22. In drawing 20, it is the hand control unit by which 40 was prepared in the insertion section and 41 was prepared in the end face section of the insertion section 40, and the curve operating knobs 43a, 43b, and 43c which carry out curve operation of the bends 42a, 42b, and 42c of the insertion section 40 are formed in this hand control unit 41.

[0045] Moreover, the eye contacting part 44 and the forceps insertion mouth 45 are formed in the hand control unit 41. This forceps insertion mouth 45 is open for free passage to the forceps channel in the insertion section 40, and the disposal implements 46, such as grasping forceps, are inserted in this forceps channel from the forceps insertion mouth 45. In addition, in the insertion section 40, built-in objects, such as a light guide fiber and an image-guide fiber, are built in.

[0046] Drawing 21 and drawing 22 are drawings showing the composition of the insertion section 40, and the insertion section 40 connects two or more **** 47a, 47b, 47c, and 47d in series through Hinges 48a, 48b, and 48c, respectively, and is constituted. **** 47a, 47b, and 47c rotate Hinges 49a, 49b, and 49c as the supporting point by the end of Wires 49a, 49b, and 49c fixing to each **** 47a, 47b, and 47c, and leading with the pulley (not shown) in which these wires 49a, 49b, and 49c were formed in the control unit 41. In addition, rotation operation of the pulley is carried out by the curve operating knobs 43a, 43b, and 43c. Moreover, 50 in drawing shows the wire guide.

[0047] Thus, in the 5th example of this invention constituted, since wire 49a connected with **** 47a, for example is led to the control unit 41 through the rotation supporting point of Hinges 49b and 49c by the wire guide 50, only hinge 49a can be rotated, without affecting Hinges 49b and 49c.

[0048] **** in which drawing 23 and drawing 24 show the 6th example of this invention to, and the inside 51a, 51b, 51c, and 51d of drawing forms a bend, The rivet with which 52a, 52b, and 52c connect **** 51a, 51b, and 51c, The curve operation wire and 54 -- which rotate **** 51a, 51b, and 51c by using Rivets 52a, 52b, and 5c as the supporting point 53a, 53b, 53c, 53d, 53e, and 53f show the wire guide.

[0049] Since the curve operation wires 53a, 53b, 53c, and 53d pass along the core of a bend, the bend of such composition can incurvate only the target bend, without affecting other bends.

[0050]

[Effect of the Invention] As explained above, according to this invention, it is not necessary to prepare the curve operation means of the number corresponding to the bend in a control unit, and the medical-application manipulator which can attain the miniaturization of a control unit can be offered.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] this invention relates to medical-application manipulators, such as an endoscope.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The endoscope generally used when inspecting visually the inside of a living body's coelome and the pipe of industrial use piping etc. consists of the insertion section inserted into a living body's coelome and the pipe of industrial use piping etc., and a control unit prepared in the end face section of this insertion section, and the bend is prepared in the nose-of-cam side of the insertion section. This bend connects two or more ***** free [rotation] by the rivet etc., is formed, and can curve freely to the vertical direction and a longitudinal direction to the shaft orientations of the insertion section.

[0003] On the other hand, the 1st curve operating knob as a curve operation means and the 2nd curve operating knob are prepared in the control unit of an endoscope free [rotation on the same axle], and the angle wire which incurvates a bend carries out attitude operation by carrying out rotation operation of these curve operating knobs at the shaft orientations of the insertion section.

[0004] By the way, since such an endoscope cannot incurvate a bend in a configuration like a wave, it has the problem that it is not easy to insert the insertion section along with the duct of complicated configurations, such as a living body's small intestine.


[0005] Then, in order to solve such a problem, two or more bends are prepared in the nose-of-cam side of the insertion section in series, and the thing which enabled it to insert the insertion section of an endoscope along with the duct of a complicated configuration is proposed.

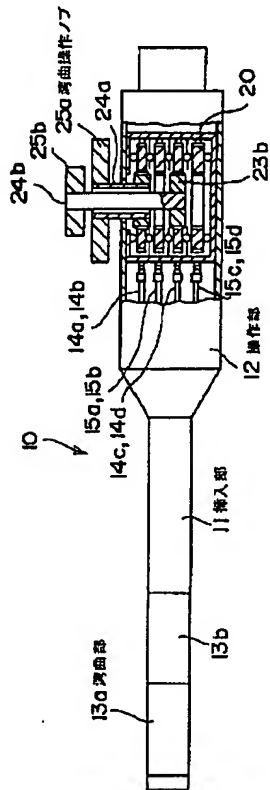
[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, according to this invention, it is not necessary to prepare the curve operation means of the number corresponding to the bend in a control unit, and the medical-application manipulator which can attain the miniaturization of a control unit can be offered.

[Translation done.]

Drawing selection [Representative drawing] 



[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, although it had the advantage that medical-application manipulators, such as such an endoscope, could insert the insertion section along with the duct of a complicated configuration, since it was necessary to prepare the curve operation means of the number corresponding to the bend in a control unit, there was a problem that a control unit was enlarged.

[0007] It was made in view of such a trouble, the purpose does not need to prepare the curve operation means of the number corresponding to the bend in a control unit, and this invention is to offer the medical-application manipulator which can attain the miniaturization of a control unit.

[Translation done.]

MEANS

[Means for Solving the Problem] this invention is characterized by providing the following in a medical-application manipulator, in order to solve the above-mentioned technical problem. The insertion section which has two or more bends in a nose-of-cam side. The control unit prepared in the end face section of this insertion section. Two or more curve operation meanses which are connected with two or more aforementioned bends of each, and carry out curve operation of each. It is prepared in the aforementioned control unit and is the external curve operation means which can be freely connected with arbitrary curve operation meanses among two or more aforementioned curve operation meanses.

[Translation done.]

OPERATION

[Function] this invention of such composition serves as a curve operational arbitrarily by external curve operation means by which two or more bends prepared in the nose-of-cam side of the insertion section were prepared by the control unit.

[Translation done.]

EXAMPLE

[Example] First, the 1st example of this invention is explained with reference to drawing 1 or drawing 13. In drawing 1, 10 shows the medical-application manipulator concerning the 1st example of this invention. This medical-application manipulator 10 consists of the insertion section 11 inserted into a living body's coelome and the pipe of industrial use piping etc., and a control unit 12 prepared in the end face section of this insertion section 11, and Bends 13a and 13b are formed in the nose-of-cam side of the insertion section 11 in series.

[0011] These bends 13a and 13b are formed with the curve tube 61 as shown in drawing 4, and this curve tube 61 has a thin-walled part 62 and a heavy-gage part 63, and has structure which is easy to curve in the direction of a thin-walled part 62 focusing on the supporting point 64 as shown in drawing 5 (a) and (b). Moreover, since this curve tube 61 has structure which it was formed by resin material, such as homogeneous PTFE, and was closed to the periphery, it has the advantage of not needing other members for maintaining sealing nature. Moreover, this curve tube 61 is fabricated by the metal mold 65 shown in drawing 6 (a) and (b).

[0012] That is, after passing material which carried out heating fusion, such as a resin, in the crevice 69 between the metal mold 65 which consists of master molds 66 and 67 and a core 68 and cooling in it, the curve tube 61 is picked out from metal mold 65. In addition, since the periphery has become toothing-like, that it is hard to insert in case it inserts into a living body's coelome, it may cut or un-arranging [of dirt adhering] may produce the curve tube 61 fabricated with the metal mold 65 shown in drawing 6 (a) and (b). In such a case, the curve tube which has the concavo-convex section in an inner circumference side can be obtained using the metal mold 70 shown in drawing 7 (a) and (b) by slushing resin material, such as PTFE, into the crevice 74 between the master molds 71 and 72 of this metal mold 70, and a core 73.

[0013] In addition, since the metal mold 70 shown in drawing 7 serves as an undercut in case it removes a curve tube from a core 73, the curve tube in this case needs to be a comparatively flexible material which permits an undercut. When selection of material with this property is difficult, as shown in drawing 9, a periphery can obtain the smooth curve tube 78 by carrying out compressed-air formula fabrication with the metal mold 75 which shows the curve tube 61 of the configuration shown in drawing 4 to drawing 8. That is, as shown in drawing 8, by inserting the curve tube 61 in metal mold 75, supplying the compressed air from an inlet 76 after heating metal mold 75, and pressurizing the pressurized room 76 of metal mold 75, the curve tube 61 imitates the smooth inner mold of metal mold 75, and is fabricated. In addition, the air which exists in the crevice between metal mold 75 and the curve tube 61 at this time is discharged from an outlet 77.

[0014] Drawing 10 shows the outline composition of the department operation equipment of low invasion peritoneal-cavity inside and outside used for the operation in peritoneal cavity under an endoscope. As shown in this drawing, this department operation equipment of low invasion peritoneal-cavity inside and outside consists of the multi-joint micromanipulator 81, the micro gripper 82, the micro clip micro suture instrument 83 for ligation, the micro substance endoscope 84, a micro tactile sensor 85, a manipulator style 86 for remote control, and three-dimensions display unit 87 grade, and conducts the operation in peritoneal cavity by the following methods. That is, a pneumoperitoneum needle is first inserted in a patient's abdomen 88, and the pneumoperitoneum of the inside of peritoneal cavity 89 is carried out. Next, the multi-joint micromanipulator 81 is inserted through the mind abdominal-pore shell truck curl 90, internal organs are held by the micro gripper 82 with a tactile sensor, and a field of operation is secured. Next, when extracting the gallbladder, the gallbladder is raised by the micro gripper 82, a RF scalpel cuts and the gallbladder is extracted, after ligating a gallbladder pipe and a vessel with the micro clip 83, as shown in drawing 11. In addition, the substance endoscope 84 carried in the multi-joint micromanipulator 81 performs observation in the peritoneal cavity 89 at this time. Moreover, a way person performs an operation by the manipulator style 86 for remote control at this time, looking at the stereoscopic image projected on the three-dimensions display unit 87.

[0015] such department operation equipment of low invasion peritoneal-cavity inside and outside of

composition -- a patient's abdomen 88 -- insertion -- since what is necessary is just to open only one hole, the degree of invasion to a patient has an advantage of a low extremely Moreover, since a way person can perform the surgical operation in peritoneal cavity, looking at the stereoscopic image in peritoneal cavity 89, he can perform an operation with the same feeling as the surgical operation by incision in the abdomen. In addition, 91 in drawing 11 shows the relative-position detection sensor.

[0016] Drawing 12 (a) and (b) are drawings showing the outline composition of the micro gripper 82 shown in drawing 10 , and this micro gripper 82 has the grasping section 92 for grasping the internal organs in peritoneal cavity. This grasping section 92 is connected to the link section 93, and the end of a wire 94 is connected to the other end of the link section 93. The other end of this wire 94 has fixed to axis-of-rotation 95a of a motor 95.

[0017] The nose-of-cam shaft of the aforementioned link section 93 is being fixed to the frame 96. The back end section of this frame 96 is connected with the front end section of a frame 98 free [rotation] through the joint section 97, and the back end section of a frame 98 is connected with the front end section of a frame 100 free [rotation] through the joint section 99. Standing ways 101 are formed in the back end section of this frame 100 at one, and the motor 102,104 is being fixed while the motor 95 mentioned above is being fixed on standing ways 101.

[0018] The end of a wire 106,107 is attached firmly to the axis of rotation 103 of the aforementioned motor 102. The other end of these wires 106,107 is attached firmly to the joint section 97 by the side of a nose of cam, and if a motor 102 is driven, one side of a wire 106,107 is pulled and another side is loosened, a frame 96 will rotate the joint section 97 as the supporting point.

[0019] The end of a wire 108,109 is attached firmly to the axis of rotation 105 of the aforementioned motor 104. The other end of these wires 108,109 is attached firmly to the joint section 99, and if a motor 104 is driven, one side of a wire 108,109 is pulled and another side is loosened, a frame 98 will rotate the joint section 99 as the supporting point.

[0020] Drawing 13 is drawing showing the outline composition of the manipulator 110 for operation formed at the nose of cam of the manipulator style 86 for remote control shown in drawing 10 , and this manipulator 110 for operation has the control unit 111 at the nose of cam. This control unit 111 is connected to the link section 112, and the end of a wire 113 is connected to the other end of the link section 112. The other end of this wire 113 is connected with the axis of rotation 115 of an encoder 114.

[0021] The nose-of-cam shaft of the aforementioned link section 112 is being fixed to the frame 116. The back end section of this frame 116 is connected with the front end section of a frame 118 free [rotation] through the joint section 117, and the back end section of a frame 118 is connected with the front end section of a frame 120 free [rotation] through the joint section 119. Standing ways 121 are formed in the back end section of this frame 120 at one, and the encoder 122,124 is being fixed while the encoder 114 mentioned above is being fixed on standing ways 121.

[0022] The end of a wire 126,127 is attached firmly to the axis of rotation 123 of the aforementioned encoder 122. The other end of these wires 126,127 is attached firmly to the joint section 117 by the side of a nose of cam.

[0023] The end of a wire 128,129 is attached firmly to the axis of rotation 125 of the aforementioned motor 124. The other end of these wires 128,129 is attached firmly to the joint section 119.

[0024] Drawing 14 is drawing showing the composition of the globe 130 for operation, and the manipulator 131 for operation is formed in the finger part shell side of this globe 130 for operation. The end face section of this manipulator 131 for operation is connected to the amount detecting element 132 of drives of a wrist outside.

[0025] Drawing 15 is the block diagram of the manipulator 131 for operation, and this manipulator 131 for operation has fixed the end of a wire 134 to the nose-of-cam side of a finger part 133, and is fixing the other end of a wire 134 to the axis of rotation of an encoder 138 through the pulley 135 of the 1st joint section, the pulley 136 of the 2nd joint section, and the pulley 137 of the 3rd joint section.

[0026] The end of a wire 139 is attached firmly to the axis of rotation of the aforementioned pulley 135. The other end of this wire 139 is attached firmly to the axis of rotation of an encoder 140. Moreover, if the globe 130 for operation of such composition of that the end of a wire 141 is attached firmly to the

axis of rotation of the aforementioned pulley 136, and the other end of this wire 141 is attached firmly to the axis of rotation of an encoder 142 makes a finger part 133 crooked, each corresponding wire 134,139,141 will be led and each encoder 138,140,142 will detect this amount of tension. The manipulator for the operation in a coelome is driven based on this detecting signal. In addition, you may transmit a detecting signal by the telemetry.

[0027] As shown in the nose-of-cam side inner skin of the curve tubes 61 and 61 which form the aforementioned bends 13a and 13b at drawing 4, the curve operation wires [14a, 14b, 14c, 14d, 15a, 15b, 15c, and 15d] end is attached firmly to the hoop direction of the curve tubes 61 and 61 at intervals of 90 abbreviation. The these curve operation wires [14a, 14b, 14c, 14d, 15a, 15b, 15c, and 15d] other end inserts in the inside of the insertion section 11, and is drawn in the control unit 12.

[0028] In the aforementioned control unit 12, as shown in drawing 1 and drawing 2, the curve operation wires 14a and 14b and chain 16a are minded for bend 13a. The 1st curve direction (It is hereafter called the "vertical direction" for convenience.) Gear 17a to incurvate, gear 17b which incurvates bend 13b in the vertical direction through the curve operation wires 15a and 15b and chain 16b, The 2nd curve direction which intersects bend 13a perpendicularly with the 1st curve direction through the curve operation wires 14c and 14d and chain 16c (it is hereafter called a "longitudinal direction" for convenience.) Gear 17d which incurvates gear 17c to incurvate and bend 13b to a longitudinal direction through curve operation wirec [15] and 15d and chain 16d is prepared.

[0029] the external tooth 18 (refer to drawing 3) for these gears 17a, 17b, 17c, and 17d making the shape of a ring, and driving Chains 16a, 16b, 16c, and 16d to the periphery side -- moreover, the internal tooth 19 (refer to drawing 3) for rotating an external tooth 18 is formed in the inner circumference side In addition, in the gearbox 20, the above-mentioned gears 17a, 17b, 17c, and 17d make the center of rotation in agreement, are held, and are held by two or more ball bearing 21 -- free [rotation], respectively. These ball bearing 21 -- is engaging with guide slot 22 -- of the shape of a ring formed in Gears [17a, 17b, 17c, and 17d] both sides, as shown in drawing 3.

[0030] Moreover, in the aforementioned control unit 12, the gears 23a and 23b which engage with the Gears [17a 17b, 17c, and 17d] internal tooth 19, and drive the Gears [17a 17b, 17c, and 17d] external tooth 18 are formed. These gears 23a and 23b are movable to the Gears [17a, 17b, 17c, and 17d] direction of the axis of rotation, and the end of connection cylinder 24a is connected with the core of gear 23a. The other end of this connection cylinder 24a is projected out of the control unit 12, and curve operating-knob 25a as an external curve operation means is attached in the protrusion edge. Moreover, the end of connecting-shaft 24b is connected with the core of gear 23b. The other end of this connecting-shaft 24b inserted in the inside of connection cylinder 24a, and has projected it out of the control unit 12, and curve operating-knob 25b as an external curve operation means is attached in the protrusion edge.

[0031] Thus, if gear 23a carries out rotation operation of the curve operating-knob 25a in the state where it is engaging with the internal tooth 19 of gear 17a, rotation of curve operating-knob 25a will get across to gear 17a through gear 23a, and chain 16a will drive the 1st example of this invention constituted by rotation of gear 17a. One side of the curve operation wires 14a and 14b is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13a curves in the vertical direction.

[0032] Moreover, if gear 23a carries out rotation operation of the curve operating-knob 25a in the state where it is engaging with the internal tooth 19 of gear 17b, rotation of curve operating-knob 25a will get across to gear 17b, and chain 16b will drive by rotation of gear 17b. One side of the curve operation wires 15a and 15b is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13b curves in the vertical direction.

[0033] Furthermore, if gear 23a carries out rotation operation of the curve operating-knob 25a in the state where it is engaging with the internal tooth 19 of both gears 17a and 17b, rotation of curve operating-knob 25a will get across to Gears 17a and 17b, and Chains 16a and 16b will drive by rotation of Gears 17a and 17b. Either the curve operation wires 14a and 14b, or 15a and 15b are pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, Bends 13a and 13b curve in the vertical direction.

[0034] On the other hand, if gear 23b carries out rotation operation of the curve operating-knob 25b in the state where it is engaging with the internal tooth 19 of gear 17c, rotation of curve operating-knob 25b will get across to gear 17c through gear 23b, and chain 16c will drive by rotation of gear 17c. Curve operation wires [14c and 14d] one side is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13a curves to a longitudinal direction.

[0035] Moreover, if gear 23b carries out rotation operation of the curve operating-knob 25b in the state where it is engaging with the internal tooth 19 which is gear 17d, rotation of curve operating-knob 25b will get across to gear 17d, and chain 16d will drive by rotation of gear 17d. Curve operation wires [15c and 15d] one side is pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, bend 13b curves to a longitudinal direction.

[0036] Furthermore, if gear 23b carries out rotation operation of the curve operating-knob 25b in the state where it is engaging with the internal tooth 19 of both which are Gears 17c and 17d, rotation of curve operating-knob 25b will get across to Gears 17c and 17d, and Chains 16c and 16d will drive by rotation of Gears 17c and 17d. The curve operation wires 14c and 14d and one side (15c and 15d) are pulled by the shaft orientations of the insertion section 11 by this, and when another side can loosen, Bends 13a and 13b curve to a longitudinal direction.

[0037] Therefore, in the 1st example of such this invention of composition, since it is not necessary to incurvate independently Bends 13a and 13b to the vertical direction and a longitudinal direction by two curve operating knobs 25a and 25b, and to prepare a curve operating knob in a control unit like before corresponding to the number of bends, the miniaturization of a control unit 12 can be attained.

[0038] In addition, although Gears 23a and 23b were made to engage with the Gears [17a 17b, 17c, and 17d] internal tooth 19 and Bends 13a and 13b were incurvated to the vertical direction and the longitudinal direction in the 1st example of this invention mentioned above Bends 13a and 13b to the vertical direction and a longitudinal direction as a gear which carries out a curve drive through the curve operation wires 14a, 14b, 14c, 14d, 15a, 15b, 15c, and 15d and Chains 16a, 16b, 16c, and 16d As shown in drawing 16 , the gears 26a, 26b, 26c, and 26d which have two external teeth 27a and 27b are used for a periphery side. Gears 23a and 23b are made to engage with these gears [26a, 26b, 26c, and 26d] external-tooth 27b, and you may make it incurvate Bends 13a and 13b to the vertical direction and a longitudinal direction.

[0039] Moreover, as shown in drawing 17 , the middle gears 28a and 28b are formed between Gears 26a, 26b, 26c, and 26d and Gears 23a and 23b, and you may make it move these middle gears 28a and 28b to Gears [26a 26b, 26c and 26d] shaft orientations by the operating rod 29.

[0040] Next, the 4th example of this invention is explained with reference to drawing 18 and drawing 19 . In addition, the same sign is attached and explained to the same portion as what was shown in drawing 1 . In drawing 18 , 30 shows the control unit of the medical-application manipulator concerning the 4th example of this invention. Gear 31a which incurvates bend 13a (refer to drawing 1) in the vertical direction through the curve operation wires 14a and 14b (refer to drawing 4) and chain 16a in this control unit 30, Gear 31b which incurvates bend 13a to a longitudinal direction through the curve operation wires 14c and 14d (refer to drawing 4) and chain 16c, Gear 32a which incurvates bend 13b (refer to drawing 1) in the vertical direction through the curve operation wires 15a and 15b (refer to drawing 4) and chain 16b, Gear 32b which incurvates bend 13b to a longitudinal direction through curve operation wire [15] and 15d (refer to drawing 4) and chain 16d is prepared.

[0041] the inside of these gears 31a, 31b, 32a, and 32b -- connection tubed to the core of Gears 31a and 32a -- Members 33a and 33b are connected these connection -- Members 33a and 33b are projected out of the control unit 30, and the curve operating knobs 35a and 35b as an external curve operation means are attached in the protrusion edge Moreover, connecting shafts 34a and 34b are connected with the core of Gears 31b and 32b. these connecting shafts 34a and 34b -- connection -- the inside of member 33a and 33b was inserted in, it has projected out of the control unit 30, and the curve operating knobs 35c and 35d as an external curve operation means are attached in the protrusion edge

[0042] Moreover, in the aforementioned control unit 30, the idler gears 36a and 36b which tell rotation of Gears 31a and 31b or Gears 32a and 32b to Gears 32a and 32b, or 31a and 31b are formed. These

idler gears 36a and 36b are held free [rotation] at the operation shaft 37, and are estranged from Gears 31a and 31b and Gears 32a and 32b by moving this operation shaft 37 to the longitudinal direction of a control unit 30.

[0043] In the 4th example of such this invention of composition, the curve operating knobs 35a, 35b, 35c, and 35d can be moved independently, and insertion to a complicated duct like the large intestine becomes easy. Moreover, curve length is freely changeable in narrow space by using only the curve operating knobs 35a and 35b, and using the curve operating knobs 35a and 35b and the curve operating knobs 35c and 35d in latus space, interlocking.

[0044] Next, the 5th example of this invention is explained with reference to drawing 20 or drawing 22 . In drawing 20 , it is the hand control unit by which 40 was prepared in the insertion section and 41 was prepared in the end face section of the insertion section 40, and the curve operating knobs 43a, 43b, and 43c which carry out curve operation of the bends 42a, 42b, and 42c of the insertion section 40 are formed in this hand control unit 41.

[0045] Moreover, the eye contacting part 44 and the forceps insertion mouth 45 are formed in the hand control unit 41. This forceps insertion mouth 45 is open for free passage to the forceps channel in the insertion section 40, and the disposal implements 46, such as grasping forceps, are inserted in this forceps channel from the forceps insertion mouth 45. In addition, in the insertion section 40, built-in objects, such as a light guide fiber and an image-guide fiber, are built in.

[0046] Drawing 21 and drawing 22 are drawings showing the composition of the insertion section 40, and the insertion section 40 connects two or more **** 47a, 47b, 47c, and 47d in series through Hinges 48a, 48b, and 48c, respectively, and is constituted. **** 47a, 47b, and 47c rotate Hinges 49a, 49b, and 49c as the supporting point by the end of Wires 49a, 49b, and 49c fixing to each **** 47a, 47b, and 47c, and leading with the pulley (not shown) in which these wires 49a, 49b, and 49c were formed in the control unit 41. In addition, rotation operation of the pulley is carried out by the curve operating knobs 43a, 43b, and 43c. Moreover, 50 in drawing shows the wire guide.

[0047] Thus, in the 5th example of this invention constituted, since wire 49a connected with **** 47a, for example is led to the control unit 41 through the rotation supporting point of Hinges 49b and 49c by the wire guide 50, only hinge 49a can be rotated, without affecting Hinges 49b and 49c.

[0048] **** in which drawing 23 and drawing 24 show the 6th example of this invention to, and the inside 51a, 51b, 51c, and 51d of drawing forms a bend, The rivet with which 52a, 52b, and 52c connect **** 51a, 51b, and 51c, The curve operation wire and 54 -- which rotate **** 51a, 51b, and 51c by using Rivets 52a, 52b, and 5c as the supporting point 53a, 53b, 53c, 53d, 53e, and 53f show the wire guide.

[0049] Since the curve operation wires 53a, 53b, 53c, and 53d pass along the core of a bend, the bend of such composition can incurvate only the target bend, without affecting other bends.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The outline block diagram of the medical-application manipulator concerning the 1st example of this invention.

[Drawing 2] The cross section showing the interior of a gear case prepared in the control unit of the medical-application manipulator concerning this example.

[Drawing 3] The A-A cross section of drawing 2.

[Drawing 4] The perspective diagram of the curve tube which forms the bend of the medical-application manipulator concerning the 1st example of this invention.

[Drawing 5] Drawing showing the curve state of this tube.

[Drawing 6] The cross section with which the structure of the metal mold for fabricating the curve tube shown in drawing 4 was shown, and (a) met the shaft orientations of metal mold, and (b) are the B-B cross section of (a).

[Drawing 7] The cross section with which the structure of the metal mold for fabricating the curve tube which has the concavo-convex section inside was shown, and (a) met the shaft orientations of metal mold, and (b) are the C-C cross section of (a).

[Drawing 8] Drawing of longitudinal section of the metal mold for fabricating the curve tube shown in drawing 9.

[Drawing 9] The perspective diagram of a curve tube.

[Drawing 10] The outline block diagram of the department operation equipment of low invasion peritoneal-cavity inside and outside.

[Drawing 11] The perspective diagram of the point of the multi-joint micromanipulator shown in drawing 10.

[Drawing 12] The outline composition of a micro gripper shown in drawing 10 is shown, for (a), it is a plan and (b) is a side elevation.

[Drawing 13] The outline composition of the manipulator for operation formed at the nose of cam of the manipulator style for remote control shown in drawing 10 is shown, for (a), it is a plan and (b) is a side elevation.

[Drawing 14] The block diagram of the globe for operation.

[Drawing 15] The block diagram of the manipulator for operation formed in the globe for operation.

[Drawing 16] The outline block diagram of the medical-application manipulator concerning the 2nd example of this invention.

[Drawing 17] The cross section showing the structure in the control unit of the medical-application manipulator concerning the 3rd example of this invention.

[Drawing 18] The cross section showing the structure in the control unit of the medical-application manipulator concerning the 4th example of this invention.

[Drawing 19] The D-D cross section of drawing 18.

[Drawing 20] The outline block diagram of the medical-application manipulator concerning the 5th example of this invention.

[Drawing 21] The block diagram of the bend of the medical-application manipulator concerning this example.

[Drawing 22] The perspective diagram of **** shown in drawing 21.

[Drawing 23] The block diagram of the bend of the medical-application manipulator concerning the 6th example of this invention.

[Drawing 24] The perspective diagram of **** shown in drawing 23.

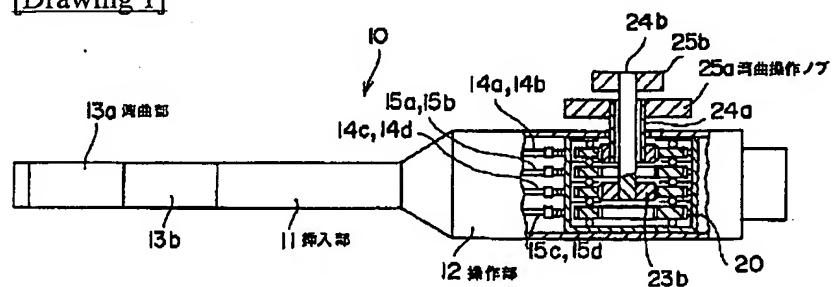
[Description of Notations]

11 [-- A bend, 14a-14d / -- A curve operation wire, 15a-15d / -- A curve operation wire, 16a-16d / -- A chain, 17a-17d / -- A gear,, 23a, 23b / -- A gear,, 25a, 25b / -- A curve operating knob, 26a-26d / -- A gear,, 28a, 28b] -- The insertion section, 12 -- A control unit,

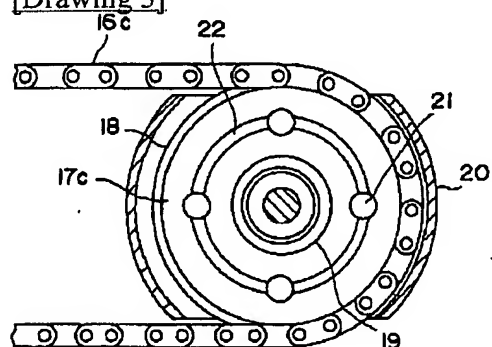
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DRAWINGS

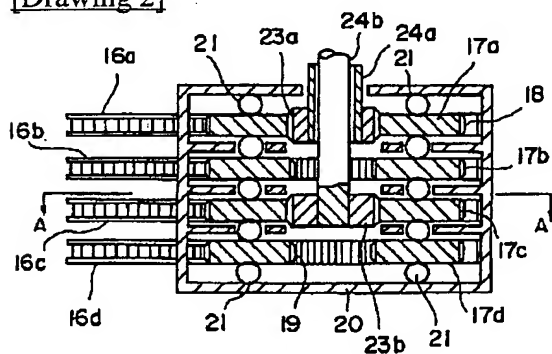
[Drawing 1]



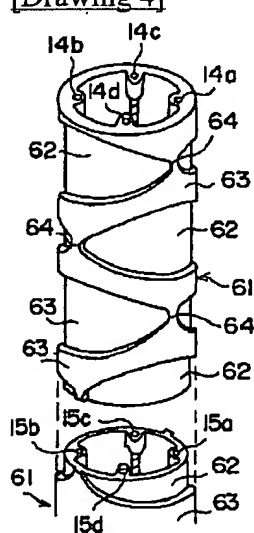
[Drawing 3]



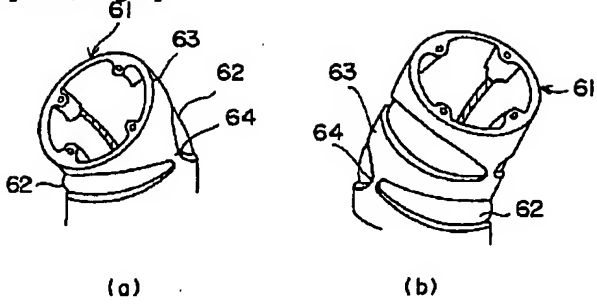
[Drawing 2]



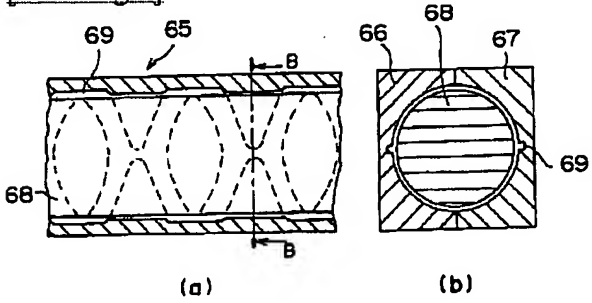
[Drawing 4]



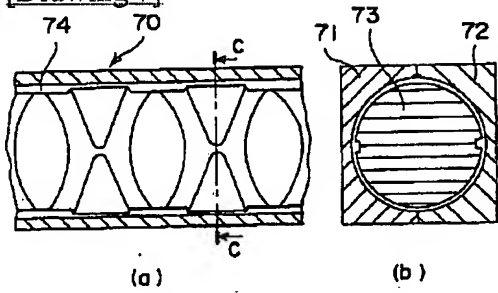
[Drawing 5]



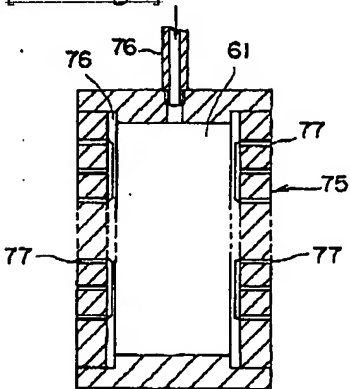
[Drawing 6]



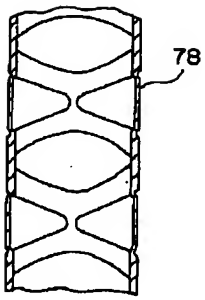
[Drawing 7]



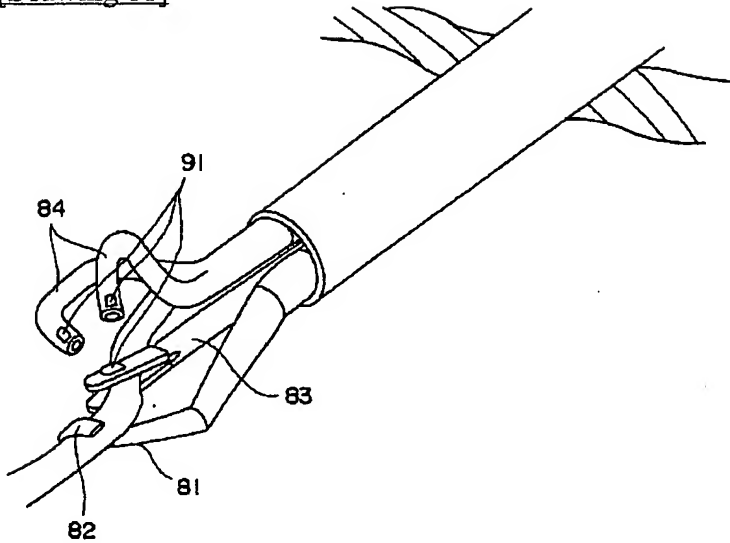
[Drawing 8]



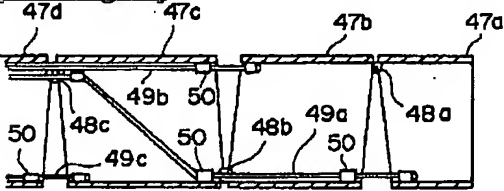
[Drawing 9]



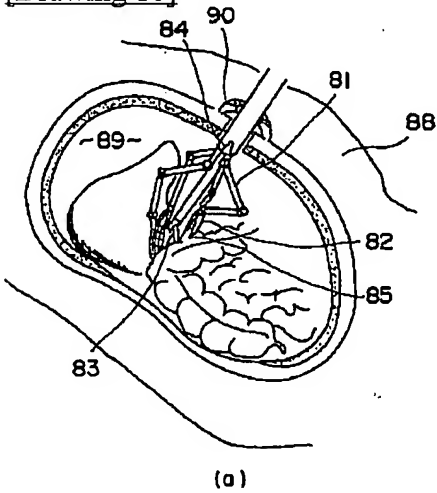
[Drawing 11]



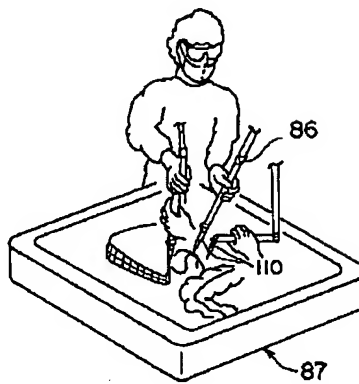
[Drawing 21]



[Drawing 10]

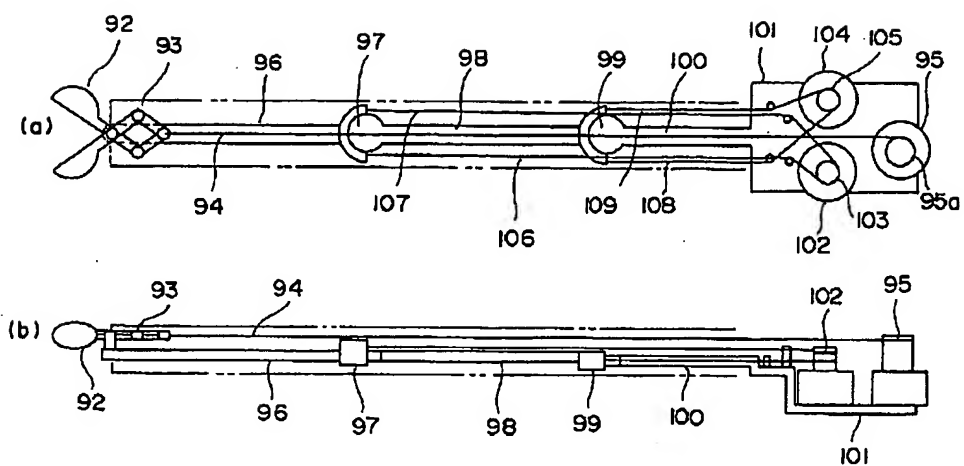


(a)

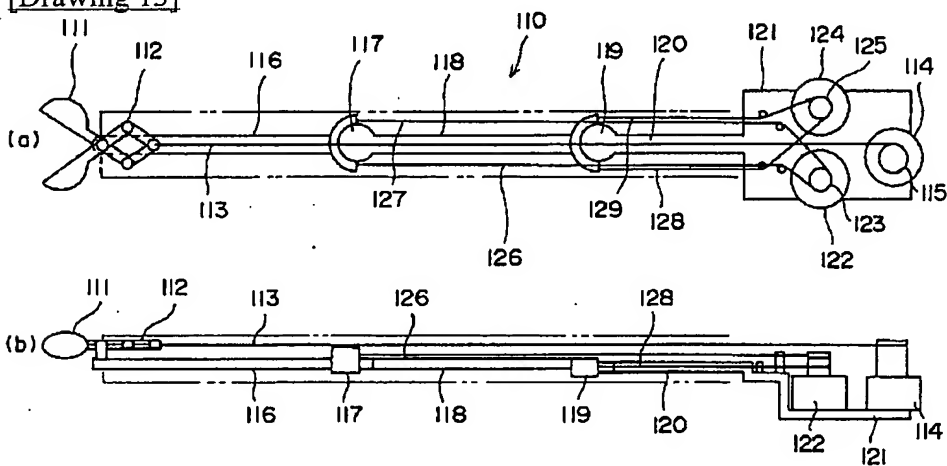


(b)

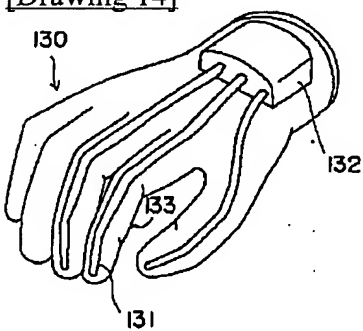
[Drawing 12]



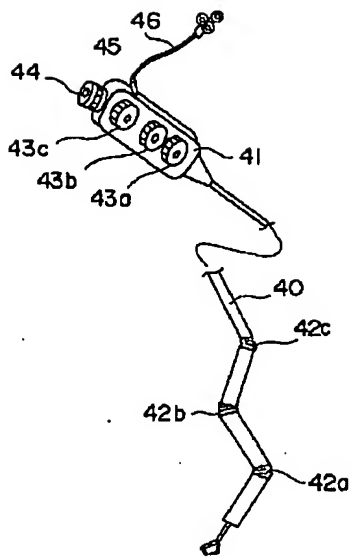
[Drawing 13]



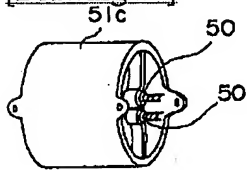
[Drawing 14]



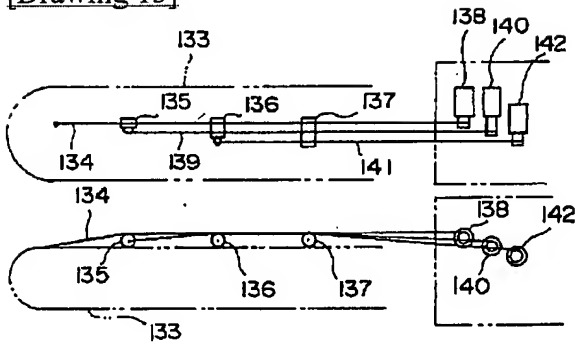
[Drawing 20]



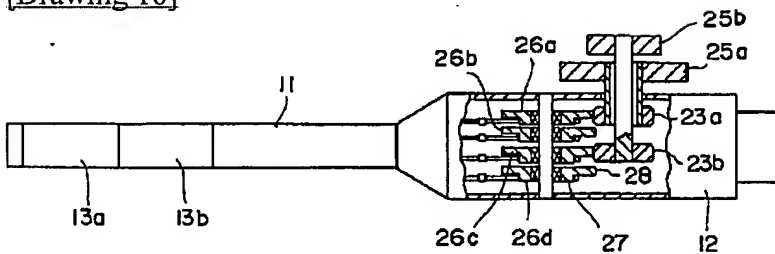
[Drawing 24]



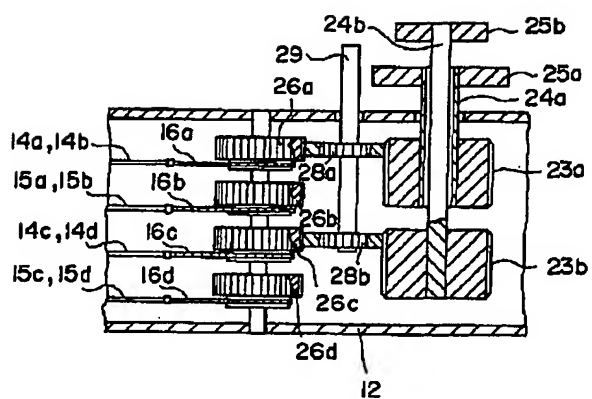
[Drawing 15]



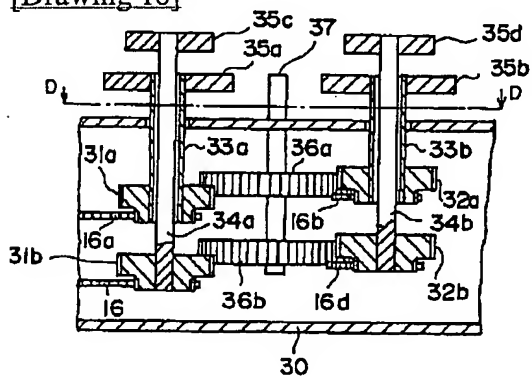
[Drawing 16]



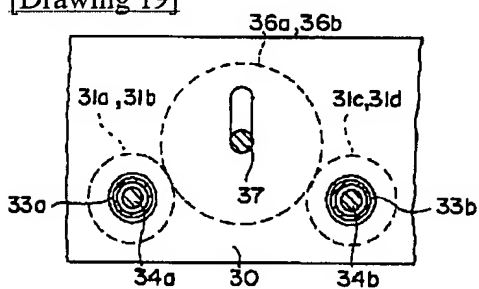
[Drawing 17]



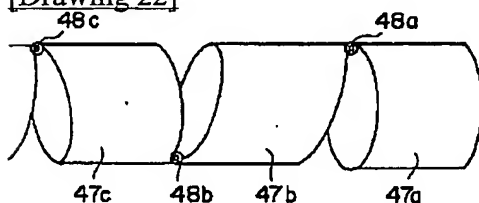
[Drawing 18]



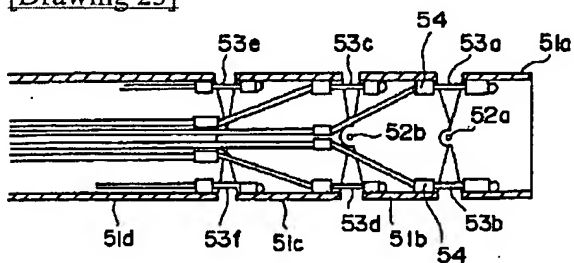
[Drawing 19]



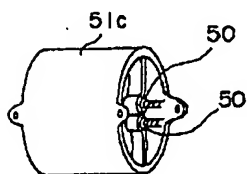
[Drawing 22]



[Drawing 23]



Drawing selection drawing 24 



[Translation done.]

[Translation done.]